

Appl. No. 10/607,722
Amendment dated July 1, 2005
Reply to Office Action date May 31, 2005

REMARKS

Initially it is noted from the PTOL-326 Form that the Examiner has mistakenly recited that only claims 1, 3 and 22-26 are pending. Claims 2 and 4 are also pending since they were not cancelled by the Preliminary Amendment dated June 27, 2003. Since claim 2 depends from claim 1 and claim 4 depends from claim 3 and claims 1 and 3 both stand rejected, this response will assume that the Examiner would have rejected claims 2 and 4 on the same grounds as stated for the rejection of claims 1 and 3.

The Examiner's objection to the disclosure as lacking the required reference to the parent application as having issued as a patent is noted. In response, applicant has inserted the issued patent No. 6,623,639 in the first paragraph of the application.

Claims 1 and 22-26 stand rejected under 35 USC 112 as being indefinite for reciting the hollow fiber membrane as a support membrane as supposedly being confusing, rendering the claim unclear as to what is supported and by what structure. In response, applicant points out that the term "support" when used in connection with separation membranes in general and hollow fiber separation membranes in particular is a term of art connoting that portion of a composite separation membrane that serves to support the active or permselective layer of the membrane. See the enclosed excerpt from the *Membrane Handbook* (1992). Accordingly, withdrawal this rejection is respectfully rejected.

Claims 1 and 22-26 stand rejected under 35 USC 103(a) as being unpatentable over Davis et al. U.S. Patent No. 4,020,142 (the '142 patent) in view of Calundann et al. U.S. Patent No. 5,091,087 (the '087 patent), Kalthod et al. U.S. Patent No. 5,779,897 (the '897 patent)

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and Ikeda et al. U.S. Patent No. 5,178,766 (the '766 patent). The Examiner reasons that the '142 patent discloses a polybenzimidazole (PBI) membrane that may be in the form of a hollow fiber that has been rendered solvent-resistant by crosslinking with a polyfunctional acid halide. The Examiner further asserts that the claimed inner diameters and wall thicknesses for such hollow fibers are disclosed at column 5, lines 33-42, and that high tensile strength and high elongation at break may be inferred from the statements at column 7, lines 48-58.

The Examiner concedes that the '142 patent does not disclose the claimed pore size of less than one micron, but asserts that it would have been obvious to one of ordinary skill in the art to have controlled manufacturing steps to result in such a pore size, since the '087 patent teaches that PBI and other membranes can be made with pore sizes smaller than one micron "depending upon particular separation applications."

The Examiner also concedes that the '142 patent does not disclose the claimed nitrogen permeance, but asserts that the '897 patent teaches the use of PBI membranes for various gas or liquid separations, that such membranes are supposedly tested for nitrogen permeation in Example 1, and that therefore it would have been obvious to one of ordinary skill to have ensured that the membrane of the '142 patent has a high nitrogen permeance "since such permeance is a known predictor of permeation coefficient of water in the liquid separation environments" disclosed in '142.

The Examiner further concedes that the '142 patent does not disclose crosslinking with multi-functional alkyl halides, but contends that the '766 patent teaches additional crosslinking of a polyamide membrane with an alkyl halide that is first crosslinked with an acid

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halide, and that therefore it would have been obvious to one of ordinary skill in the art to have so modified '142 by adding an alkyl halide crosslinking step as supposedly taught by '766 so as to increase the membrane's rejection of electrolytes while maintaining a high flux.

As to claims 22-24, the Examiner asserts that the '142 patent discloses contacting a membrane with a crosslinking solution while heating for periods of minutes to hours, pointing to column 6, lines 59 through column 7, line 34.

Finally, regarding claims 25-26, the Examiner asserts that the '897 patent teaches coating hollow fiber membranes, including PBI membranes, with selective coatings, pointing to column 9, lines 3-4 of '897.

The foregoing obviousness rejection is respectfully traversed for the following reasons, the most fundamental of which is that none of the four references relied upon teach crosslinking a PBI membrane with an alkyl halide.

Applicant has amended claim 1 to specify that the PBI membrane is crosslinked with an alkyl halide having the general structures set forth in the specification at page 7, lines 1-24. Note that there is no acid or carboxyl or sulfonyl group in such structures. This is significant inasmuch as the primary reference relied upon by the Examiner (the '142 patent), in its most pertinent aspect, only discloses acid halides containing either carboxyl or sulfonyl groups. See column 6, lines 52-57. Thus, without more, claim 1 is readily distinguishable from the primary reference relied upon by the Examiner. Since claims 2 and 22-26 all ultimately depend from claim 1 and so contain the same limitations as claim 1, those claims are likewise distinguishable

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from the '142 patent. And none of the three secondary references cited by the Examiner supply this fundamental deficiency of the '142 patent.

There are other shortcomings in the teachings of the '142 patent as well. Specifically, the Examiner is submitted to be in error in asserting that applicants' claimed inner diameter of the support fiber of from about 200 to about 1000 microns is disclosed in the '142 patent; instead, '142 discloses an inner diameter "of about 25 to 150 microns." See column 5 at lines 37-38. And the Examiner's assertion that "high" tensile strength and "high" elongation at break may be inferred from the generalized statements at column 7, lines 48-58 of the '142 patent to the effect that the disclosed PBI membranes are stronger, more flexible and tougher than the starting material and exhibit a lesser tendency to undergo shrinkage and resist compaction is submitted to be an unwarranted broad interpretation inasmuch as the statements in question do not recite any particular quantification of those characteristics. Note that applicant's claims quantify both tensile strength and elongation at break.

Applicant concedes that '087 teaches pore sizes of less than one micron, but respectfully points out that '087 is not concerned with the manufacture of hollow fiber crosslinked membranes, but rather with flat sheet membranes that are prepared by scinterring and high compression molding pressures. And there is nothing in '087 concerning the particular crosslinking agents claimed by applicant.

The Examiner asserts that the '897 patent tested PBI membranes for nitrogen permeation in Example 1. Even conceding for purposes of argument that the Examiner is correct in this assertion, the fundamental fact is that neither the primary reference (the '142 patent) nor

any of the secondary references teach crosslinking by an alkyl halide. However, applicant respectfully takes issue with the Examiner's interpretation of '897. Specifically, the modules of Example 1 were tested for air drying and for water removal. Nitrogen was used merely as a countercurrent sweep to the feed to produce a large driving force for permeation of water vapor. See Column 10, lines 46-49. The purpose of a sweep gas in a membrane separation module is to sweep away permeating components. Note that no data are given in Table 2 of '897 pertaining to Example 1 of any nitrogen permeance and that there is no statement in Example 1 to the effect that the nitrogen sweep permeates the membrane.

As to crosslinking with an alkyl halide, the Examiner asserts that the '766 patent teaches additional crosslinking of a polyamide membrane with an alkyl halide, pointing to column 5, lines 15-26. Initially, it is noted that a polyamide membrane is not a PBI membrane and there is no teaching of record to the effect that they are chemically equivalent when it comes to crosslinking. Beyond this, a careful reading of the excerpt from '766 relied upon by the Examiner shows that no crosslinking of even the polyamide membrane by an alkyl halide takes place. Specifically, after the crosslinked polyamide is formed, the remaining amino groups in the crosslinked polyamide are converted to "quaternary alkyl ammonium by treating the crosslinked polyamide with an alkyl halide." See column 5 at lines 19-26. In other words, further treatment of the crosslinked polyamide with an alkyl halide results not in further crosslinking, but rather in the conversion of remaining amino groups to quaternary alkyl ammonium groups. Thus, neither '142 nor '766 teach crosslinking a PBI membrane with an alkyl halide.

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As to claims 22-26, applicant concedes for purposes of argument the Examiner's assertions concerning the teachings of the '142 and '897 patents. However, '142 does not disclose crosslinking with an alkyl halide as pointed out above and '897 does not specify any of selective coatings claimed by applicant in claim 26.

Finally, claim 3 stands rejected under 35 USC 103(a) as being unpatentable over the '897 patent in view of the '087 patent, the '766 patent and the '142 patent, the Examiner reasoning that '897 discloses a hollow fiber separation module of the same configuration as that claimed, and that the three secondary references disclose or suggest the various deficiencies in the disclosure of '897. This rejection, as well as the implied rejection of dependent claim 4, are respectfully traversed as well for the following reasons.

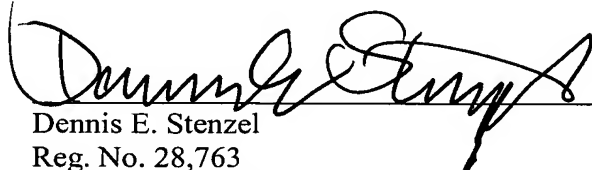
The Examiner concedes that the '897 patent does not disclose crosslinking a PBI hollow fiber membrane with a multi-functional halide, but asserts that the '142 patent does disclose such a crosslinking step. For the same reasons set forth above in connection with the discussion of the '142 patent, and given that claim 3 as amended specifies that the crosslinking takes place with the specified alkyl halides, the Examiner's position now lacks a proper factual foundation.

The Examiner also concedes that the '897 patent does not disclose crosslinking with multi-functional alkyl halides, but asserts that '766 discloses such a crosslinking step for a polyamide membrane. Again, for the reasons stated above in connection with the discussion of the '766 patent and its purported disclosure on this point, the Examiner's position is respectfully submitted to lack a factual foundation.

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For the reasons stated, early and favorable reconsideration is respectfully
solicited.

Respectfully submitted,


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CERTIFICATE OF MAILING

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July 1, 05
Date


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